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TRACTOR TUNE-UP AND MAINTENANCE. AGRICULTURAL MACHINERY--SERVICE OCCUPATIONS, MODULE NUMBER 13.
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ONE OF A SERIES DESIGNED TO HELP TEACHERS PREPARE POSTSECONDARY STUDENTS FOR THE AGRICULTURAL MACHINERY SERVICE OCCUPATIONS AS PARTS MEN, MECHANICS, MECHANIC'S HELPERS, AND SERVICE SUPERVISORS, THIS GUIDE AIMS TO DEVELOP STUDENT UNDERSTANDING OF A SYSTEMATIC PROCEDURE AND ABILITY TO PERFORM TUNEUPS AND MAINTENANCE TASKS. IT WAS DEVELOPED BY A NATIONAL TASK FORCE ON THE BASIS OF RESEARCH FROM STATE STUDIES. SUGGESTIONS FOR INTRODUCING THE MODULE ARE GIVEN. SUBJECT-AREA UNITS INCLUDE--(1) ECONOMIC IMPORTANCE OF PROPER TUNING, (2) MAJOR COMPONENTS OF A FARM TRACTOR, (3) VALVE ADJUSTMENT, (4) ELECTRICAL AND IGNITION ADJUSTMENT, (5) AIR, FUEL, AND EXHAUST SYSTEM ADJUSTMENT, (6) COOLING SYSTEM MAINTENANCE AND ADJUSTMENT, AND (7) POWER TRAIN MAINTENANCE AND ADJUSTMENT. EACH UNIT INCLUDES SUGGESTED SUBJECT-MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, SUGGESTED MATERIALS, AND REFERENCES. SUGGESTED TIME ALLOTMENT IS 24 HOURS OF CLASS INSTRUCTION AND 48 HOURS OF LABORATORY EXPERIENCE. TEACHERS SHOULD HAVE EXPERIENCE IN AGRICULTURAL MACHINERY. STUDENTS SHOULD HAVE MECHANICAL APTITUDE AND AN OCCUPATIONAL GOAL IN AGRICULTURAL MACHINERY. SUGGESTIONS FOR EVALUATING EDUCATIONAL OUTCOMES ARE INCLUDED. THIS DOCUMENT IS ALSO AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 488 THROUGH VT 000 504) FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212, FOR $7.50 PER SET. (JM)

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TRACTOR TUNE - UP AND MAINTENANCE

One of Sixteen Modules in the Course Preparing for Entry in

AGRICULTURAL MACHINERY - SERVICE OCCUPATIONS

Module No. 13

The Center for Research and Leadership Development
in Vocational and Technical Education

The Ohio State University
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MEMORANDUM

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TRACTOR TUNE-UP AND MAINTENANCE

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TRACTOR TUNE-UP AND MAINTENANCE

Major Teaching Objective

To understand a systematic procedure to follow and be able to effectively tune and maintain a farm tractor.

Suggested Time Allotments

At school		
Class instruction	24 hours	
Laboratory experience	48 hours	
Total at school		72 hours
Occupational experience		0 hours
Total for module		72 hours

Suggestions for Introducing the Module

A person preparing for employment as a mechanic, mechanic's helper, or service supervisor in an agricultural machinery business must be able to effectively tune and maintain a farm tractor. An efficient employee in these occupations will have an understanding of the importance of a properly tuned tractor, will have an effective systematic procedure to follow in "checking out" a tractor, and will possess the technical knowledge and abilities necessary to make the needed adjustments.

Competition is keen in many areas of the farm machinery service business and the progressive employer will be interested in only the efficient employee.

The following technique should be used to create interest in the module.

Bring a small tractor before the class. Alter the electrical system so that the tractor won't start and set the idling jet on the carburetor to a very slow idle. Demonstrate to the class that the tractor won't start. Give the students an opportunity to find the trouble. Show them how a simple little malfunction of the electrical system can keep the engine from functioning. Once the tractor is running and the idling difficulty is identified, have the student attempt to correct it. Emphasize how simple it is to make tune-up adjustments and how important it is to have a thorough understanding of the engine, its parts, and their functions, in order to be able to perform proper tune-up and maintenance.

Competencies to be Developed

I. To understand the economic importance of a properly tuned tractor

Teacher Preparation

Subject Matter Content

Studies conducted by agricultural engineers have shown that most farm tractors are not operating at the power and efficiency of which they are capable. Often this is caused by tractors which have not been properly tuned being delivered to farmers. To eliminate this situation, it is necessary that many persons planning an occupation in an agricultural machinery dealership possess the competencies needed to properly adjust and tune a tractor.

Studies have shown that proper tuning of the average farm tractor increased its horsepower eleven per cent. Fuel use efficiency was increased fourteen per cent for a saving of about five gallons per day on a fifty horsepower tractor while being used for plowing.

Implement companies are well aware of the need for adequately trained employees. Often implement companies are blamed for tractor troubles that could have been prevented by properly tuning and adjusting the tractors before delivery.

Suggested Teaching-Learning Activities

1. Have students develop graphs showing performances of properly adjusted tractors as compared with tractors not properly adjusted.

2. By the use of a gasoline flow meter, demonstrate to students the difference in fuel consumption when the tractor engine is properly timed and not timed and when the carburetor is properly adjusted and not adjusted.

3. By use of a dynamometer, demonstrate the difference in horsepower in properly and improperly tuned engines.

4. Have a local farm machinery service manager bring to the class the past month's service records of customers to illustrate a comparison of the average cost of tune-up and maintenance and the total value of the equipment that was serviced. Have him point out the savings that could have

been made by more timely maintenance. Have him point out instances where a mechanic's inability to perform proper maintenance and tune-up has resulted in additional service calls and lack of confidence in the dealership.

5. The governor on the tractor motor must be properly adjusted before any adjustment can be made while under test by the dynamometer. Show the difference between improper speed of engine and horsepower compared to proper speed of engine and horsepower.

Suggested Instructional Materials and References

Instructional Materials

1. Charts and graphs depicting the increased cost in operating an improperly tuned tractor
2. A gasoline flow meter to be used in determining the rate of fuel consumption
3. Dynamometer

References

S*1. Tractor Maintenance: Principles and Procedures, pages 1-3.

S 2. Gulf Farm Tractor Guide, page 1.

T 3. "Nebraska State Test Chart for P.T.O. Speed, Fuel Compression and Horsepower."

S 4. Implement and Tractor Tune-up Specifications.

*The symbol T (teacher) or S (student) denotes those references designed especially for the teacher or for the student.

II. To understand the construction and major components of a farm tractor

Teacher Preparation

Subject Matter Content

The ability to adjust and tune a tractor without an understanding of its construction, major components and their relationships to each other is very unlikely. Persons performing this type of service must have this understanding to develop and follow a systematic method of checking the components to make proper adjustments.

Tractors are composed of hundreds of parts. The smaller parts are built into major systems or assemblies such as:

1. Engine and accessories
2. Power train
3. Brakes
4. Steering mechanism
5. Chassis and related parts
6. Cooling system
7. Ignition system
8. Fuel system
9. Lubrication system

All farm tractors, except some experimental models, have internal combustion engines as the source of power.

Major assemblies of engines and their components are:

1. Engine
    a. Cylinder block and cylinder head
    b. Pistons and rings
    c. Connecting rods
    d. Rocker arm assembly

e. Oil pan, oil pump, and oil filter

f. Valves and valve springs

g. Camshaft and camshaft gear

h. Crankshaft

i. Flywheel

j. Timing gear

k. Main bearings

2. Engine accessory systems

a. Electrical and ignition system

1) Battery
2) Generator and charging circuit
3) Ignition circuit (spark plugs and glow plugs, coil, distributor, magneto, cranking motor)

b. Fuel, air, and exhaust systems - gasoline

1) Air cleaner
2) Fuel tank
3) Fuel line, cutoff valve, strainer and filter
4) Fuel pump - only for tractors that do not have the fuel tank located above the engine
5) Carburetor
6) Manifold, muffler, and exhaust
7) Governor

c. Fuel, air, and exhaust systems - diesel

1) Air cleaner
2) Fuel tank
3) Fuel lines and filter
4) Fuel injectors
5) Fuel injection pump
6) Manifold, muffler and outlet pipe
7) Governor

d. Fuel, air, and exhaust systems - LP Gas

1) Air cleaner
2) Fuel tank, valve, and line
3) Fuel filter
4) Carburetor
5) Pressure regulators and vaporizer
6) Manifold, muffler, and exhaust pipe
7) Governor

e. Cooling systems

1) Radiator, hose, and pressure cap
2) Water pump

3) Thermostat
4) Fan

f. Power train

1) Clutch
2) Transmission
3) Differential
4) Final drive or driving axles

g. Brakes

1) Pedals or levers
2) Drums
3) Bands
4) Shoe assemblies
5) Disk assemblies
6) Rods
7) Hydraulics
8) Power brakes

h. Steering mechanisms

1) Steering shaft
2) Bolster
3) Axle
4) Radius rod
5) Spindles
6) Tie rods
7) Drag link
8) Gears
9) Hydraulic and power steering

i. Chassis, wheels, and lights

1) Chassis frame
2) Front and rear lights
3) Wheels and tires

Suggested Teaching-Learning Activities

1. Have students develop written reports on a general type tractor construction, naming assemblies and systems and stating functions of each system. Also have students list how systems vary according to types of tractors.

2. Have students identify major components on a diagram of a general type tractor

3. Disassemble the major systems of a tractor to the extent that the components as listed in the content may be seen and studied by the students. Reassemble the components explaining the function of all components in a system.

Suggested Instructional Materials and References

Instructional Materials

1. Overhead transparencies and chart diagrams of cross section view of a tractor showing its assemblies and systems

2. Overhead transparencies and chart diagrams of exploded view of tractor systems showing major components of each system

3. A tractor

References

T 1. Tractors and Crawlers

S 2. Ford Tractor: Shop Manual

III. To adjust valves in tractor engines

Teacher Preparation

Subject Matter Content

High speeds, high temperatures, and increased compression place severe demands on engine valves. Improperly adjusted valves reduce the efficiency of the engine and accelerate wear thereby causing the need for early overhaul. When properly adjusted:

1. Valves last longer.

2. The engine uses fuel more efficiently.

3. The engine starts more easily.

4. Maximum power is produced.

5. The engine is less likely to overheat.

6. Smooth engine operation is provided.

Terms such as "tappet adjustment," "valve clearance," "valve spacing," and "valve lash" - all refer to valve clearance adjustments.

A properly adjusted valve will usually have a clearance of .006 inch to .030 inch between the valve stem and the rocker arm when the valve is closed. This varies according to the manufacturer and whether the engine is hot or cold. When performing engine tune-up jobs, it is advisable to follow suggestions in the operator's manual provided by the manufacturer.

Steps in the procedure listed should be followed when making valve clearance adjustments for valve-in-head engines.

1. Check operator's manual to determine whether engine should be hot or cold to make valve adjustments.

2. Remove tractor parts that interfere with removal of valve cover.

3. Clean dirt from valve cover and from around spark plugs.

4. Remove nuts or cap screws that hold valve (rocker-arm) cover.

5. Carefully remove valve cover to protect gasket.

6. Disconnect the center terminal wire to the distributor on spark ignition engines and shut off the fuel supply on diesel engines. This is a safety precaution.

7. Check cylinder head for tightness.

8. Slowly turn crankshaft until piston in number 1 cylinder is at top dead center (TDC) of compression stroke.

9. Visually inspect all parts making sure that all parts getting oil are not sludged.

10. Select the feeler-guage thickness recommended by the manufacturer.

11. Check clearance by inserting guage between valve stem and rocker arm of intake and exhaust valves. If clearances are correct on both, proceed with step 14.

12. Loosen adjusting-screw lock nut on valve rocker arm.

13. Turn adjusting screw with screwdriver until feeler guage will just slip in and out of the gap.

14. Hold adjusting screw with screwdriver and tighten lock nut with wrench. Then re-check.

15. Determine which cylinder fires next.

16. Crank engine until next cylinder in firing order is on compression. (TDC)

17. Adjust valves following same procedures as on number 1 cylinder and proceed in same manner with remaining cylinders.

18. Start engine and check lubrication of rocker arm.

19. Reassemble gasket, cover, etc.

Suggested Teaching-Learning Activities

1. Have students become familiar with instructions in operator's manuals through reading assignments and question and answer periods.

2. Demonstrate to students a procedure for determining when a piston is at TDC on the compression stroke.

3. Demonstrate to the class how the firing order may be determined and have a class member repeat the demonstration to be critiqued by other class members.

4. Have students give reasons for proper valve adjustments and list step by step the procedure to follow in adjusting valves.

5. Have students list ways of determining whether valve adjustment or overhaul is needed.

6. After having one student attempt to adjust valves in a late model engine using an out-of-date service manual as a guide, follow through step-by-step with the possible consequences of such a procedure to impress upon all students the necessity for keeping up-to-date in maintenance procedures.

Suggested Instructional Materials and References

Instructional Materials

1. Tractor engines
2. Operator's manuals
3. Overhead transparencies and diagrams of piston and crankshaft positions of cylinders and valves
4. Tools necessary for the competency

References

1. Tractor Maintenance: Principles and Procedures, pages 34-42.
2. Farm Tractor Tune-Up and Service Guide.
3. Operator's manuals for tractors.
4. Tractor Maintenance and Tune-Up, pages 7-10.

Suggested Occupational Experiences

Have students follow the recommended procedure for adjusting valves on at least two engines.

IV. To adjust and tune tractor electrical and ignition systems

Teacher Preparation

Subject Matter Content

The electrical system of a gasoline tractor provides ignition which is one of the three essentials for combustion. Ignition in a diesel engine is provided by the high temperature generated during the compression stroke.

Properly tuned ignition systems add efficiency and life to the operation of the tractor. A systematic approach to adjusting and tuning the ignition system includes cleaning, "checking out," and adjusting each major component. (Refer to illustration 63, page 33 in the reference entitled "Electrical.")

The purpose of the battery is to convert chemical energy into electrical energy. An unclean and corroded battery becomes weak and dead much more quickly than one kept in proper condition.

Procedure for testing, cleaning, and servicing batteries:

1. Check battery with a voltmeter or hydrometer to determine the degree of charge of the battery.

BATTERY SPECIFIC GRAVITY CHARGE

State of Charge	Specific Gravity Temperate Climates
Fully Charged	1.275
75%	1.250
50%	1.225
25%	1.200
Discharged	1.175

2. Disconnect cable and ground strap from battery terminals if they are corroded.

3. Clean cable clamps and battery posts with wire brush and sandpaper.

4. Remove loose dirt and corrosion particles.

5. Brush a soda and water mixture on top of battery, on posts, and on clamps.

6. Wash away residue with clean water.

7. Repeat steps "5" and "6" until there is no further foaming.

8. Dry top of battery with a clean cloth or install corrosion inhibitor belt disks under clamps.

9. Apply a coating of light grease to posts and cable clamps.

10. Reconnect cable and ground strap.

The generator is the source of power in battery-type tractor electrical systems. It is usually belt driven and located at the front of the tractor.

The starter or "cranking motor" is used for starting the motor and is located on the side next to the flywheel housing.

Some tractor manufacturers are installing alternators in place of generators on their tractors. The difference between them is that the generator develops direct current which is suitable for direct use by the battery and electrical equipment on the tractor. The alternator develops alternating current which must be "rectified" -- changed to direct current -- before it can be used. Servicing an alternator is considered more technical than the term "tune-up" usually implies. The following procedure should be followed in maintaining and checking the starter and generator.

1. Wipe dirt from starter or generator housing.
2. Remove cover band.
3. Check brushes for wear and binding action.
4. Inspect for thrown solder.
5. Replace worn brushes.
6. Check brushes for binding action in holder.
7. Check electrical connections for tightness.
8. Inspect commutator for wear and roughness.
9. Remove dirt and glaze from commutator surface.
10. Set and seat new brushes on commutator.
11. Blow dust from commutator, brush holders and casing.
12. Replace band.
13. Polarize the generator before starting the engine.
14. If the generator needs reconditioning, proper methods should be used in the reconditioning process. Included in this process should be that of turning on a lathe, polishing and under-cutting the mica.
15. Check starter bendix drive and lubricate with light out.

Generator polarity refers to the direction of current flow from the generator to the extended circuits. Failure to polarize the generator in agreement with the battery may result in burned cut-out relay points, a discharged battery, or serious damage to the generator.

Gasoline engines used in tractors depend upon electricity to ignite the fuel and air mixture in the combustion chamber. Ignition takes place when a spark occurs in the combustion chamber. The spark takes place when electricity jumps across the gap between the electrodes of a spark plug. The spark must occur at the proper time in the combustion chamber so that the burning fuel can exert pressure on the piston to cause the crankshaft to rotate.

The electrical circuit which provides the spark at the spark plug is known as the ignition circuit. (Refer to Ford Tractor: Shop Manual for diagram of electrical system.)

Spark plugs provide the spark in the combustion chamber to ignite the fuel-air mixture.

Tests have shown that properly conditioned spark plugs may increase horse power of an engine by as much as 8.6 per cent. Tests have also shown that properly conditioned spark plugs may decrease fuel consumption by as much as 6.1 per cent.

In the same tests it was found that new spark plugs increased horsepower 21.5 per cent and decreased fuel consumption 14.2 per cent.

Spark plugs vary in type and size according to:

1. Engine design
2. Kind of fuel used
3. Engine operating conditions

(Refer to examples in Modern Farm Power, page 111 and Farm Tractors: Basic Principles, Operation, and Maintenance, pages 54-55.)

Conditioning spark plugs should be done according to the following procedure:

1. Disconnect spark plug wires from plugs.
2. Loosen plugs one or two turns, then remove dirt.

3. Remove each plug and arrange so each plug can be identified with its cylinder.

4. Check the condition of each plug. Plugs that are worn should be replaced with new ones.

5. Remove oily deposits from plugs.

6. Clean threads with a wire brush.

7. Remove deposits from plugs.

8. Blow loose material from plugs.

9. File electrodes on plugs until both have flat surfaces.

10. Determine proper spark gap spacing.

11. Regap plugs and check using the proper sized wire feeler guage.

12. Replace plugs with gasket and tighten with fingers.

13. Completely tighten plug with a spark plug socket wrench or torque wrench to specifications.

14. Check connections and insulation on spark plug wires when reattaching them to spark plugs.

15. Check polarity of spark at spark plug.

16. A dynamometer check should be made after each adjustment to observe what is happening to the horsepower output of the engine.

Glow plugs are used to aid starting and provide a fast "clean up" of the exhaust in diesel engines. It is important that all glow plugs function properly to eliminate misfiring during warm up.

Faulty plugs, when the tip is burned away or when the sheath is ruptured, should be replaced.

Coils are used in ignition systems to increase the voltage of the electrical current needed to provide the spark in the combustion chamber. Coils will increase current from 6 or 12 volts up to 25,000 volts. Relatively little adjustment is needed for proper maintenance of coils.

Maximum performance and efficiency of an engine can be attained only if the spark occurs in the right cylinder at the right time. This is the function of the distributor which includes a cam that opens and closes the points and a rotor and cap which distributed the spark to the correct cylinder. This function is performed only if the ignition timing is correct.

Servicing the distributor and timing the ignition system are usually considered as tune-up jobs. (Refer to the reference entitled Farm Tractors: Basic Principles, Operation, and Maintenance, pages 48 and 49 for an example of a distributor.)

1. Servicing the Distributor

   a. Checking the condition of the distributor
      To perform this operation follow this procedure:

      1) Remove dirt from outside surface of distributor cap.
      2) Remove cap and clean inner surfaces. Leave wires connected.
      3) Check distriburor capfor chips, cracks, and carbon paths which indicate cross arcing.
      4) Remove distributor arm (rotor) and clean.
      5) Remove dust cover, if one is used, and check condition of felt seal.
      6) Check the centrifugal-advance mechanism.
      7) Check condition of breaker points. If the contact points are rough but show only slight pitting and metal deposit, smooth with an ignition file. If points are badly pitted and worn, replace them with a new set.
      8) Check condenser to make sure it is working properly. An improperly working condenser will cause a cone shaped deposit of metal on one point and a cone shaped pit on the other.

         If this condition is existing, check tightness of the screw that holds the condenser. If the screw is tight, check the condenser with a condenser tester to determine whether it should be replaced.

   b. Replacing breaker points

      1) Remove breaker arm and spring.
      2) Remove stationary breaker point and bracket.

3) Clean, then lubricate cam with special cam lubricant or with petroleum jelly or multi-purpose grease.
4) Install new points in reverse order.

c. Adjusting breaker points

1) Turn engine until cam opens breaker points to widest position.
2) Check points for proper spacing. Check operator's manul for correct spacing. This may vary from .015 to .026 inch.
3) Loosen lock screw on bracket that provides adjustment.
4) Adjust points for proper spacing and alignment.
5) Lock breaker points in position with lock screw.
6) Recheck gap between points and wipe points clean.

d. Reassembling the distributor

1) Lubricate wick in center of cam shaft.
2) Reassemble distributor in reverse order from that outlined in "checking the condition of the distributor."
3) Check condition of wires leading to spark plugs and to ignition coil.

2. Timing the Ignition - Spark Ignition Engines

Timing the engine may be done by two methods:

a. The breaker point method

b. The timing light method

The timing light method is the most accurate. Proper timing means that the ignition is set so the distributor will supply a spark to each cylinder at a time when the fuel will burn with greatest efficiency.

a. Timing by the breaker point method

1) Locate timing marks on flywheel or fan pulley.
2) Loosen or remove spark plug from number one cylinder.
3) Remove distributor cap.
4) Crank the engine until number 1 cylinder starts compression stroke. Watch which way the distributor rotor is turning.

5) Continue to rotate slowly until proper marking appears on flywheel or fan shaft pulley. Check operator's manual for marking to indicate top dead center (TPC) for number on cylinder.
6) Remove rotor and dust cap.
7) Note if breaker points are just starting to open. If breaker points are just starting to open, the timing is satisfactory and the distributor may be reassembled. If points are closing, continue with remaining steps.
8) Loosen clamps that hold distributor to engine block.
9) Turn the distributor slowly in the direction the rotor normally turns. This step is to make sure the breaker points are completely together.
10) Turn distributor body slowly in opposite direction until points start to open.
11) Tighten clamps that hold distributor body and reassemble distributor.
12) Tighten number one spark plug and attach spark plug wire.
13) Start the engine to see that it operates satisfactorily.
14) If you removed a cover from over the timing hole, replace it.

b. Timing by the timing light method

1) Locate timing marks on flywheel or fan pulley.
2) Connect timing light as recommended by manufacturer.
3) Determine from the operator's manual what timing mark to use with light.
4) Chalk the timing mark so it is easy to see.
5) Start engine and run at speed recommended in operator's manual.
6) Direct timing light at markings on the flywheel or on fan pulley.
7) Loosen clamps that hold distributor.
8) Turn distributor body slightly until timing mark is opposite pointer.
9) Tighten distributor and remove timing light.
10) Replace cover over timing hole if one was removed.

Magnetos are self-contained assemblies which are driven by the engine and supply high voltage current to the spark plugs.

Magnetos contain a coil, condenser, points, distributor, cap, and rotor. Magnetos with a spring loaded drive turn quickly at slow speeds when a cylinder is to fire, thus generating more voltage and resulting in a better spark while starting the engine.

Maintenance procedures for magnetos are very similar to those for battery powered ignition systems.

Suggested Teaching-Learning Activities

1. Have students prepare an engine electrical system from spare parts using cutaway components and then explain and trace the operation of the electrical system.

2. Have students diagram an engine electrical system showing each major assembly and component.

3. Have students list conditions which may cause fouling or failure of the assemblies of the electrical system.

4. Demonstrate to students a procedure for tuning the electrical system.

5. Have students develop a check list of trouble shooting procedures for an electrical system.

6. Have students trouble shoot and service a tractor's electrical system that has been incorrectly serviced by the instructor.

7. Have students practice installing and timing magnetos where interchangeable with battery system.

Suggested Instructional Materials and References

Instructional Materials

1. An engine electrical system mounted on a display board

2. Overhead transparencies listing the steps to follow in maintaining and tuning the electrical system

3. Electrical systems for students to use

4. Charts and diagrams of exploded views of the components of an electrical system

5. "Electrical System," University of Nebraska Filmstrip

References

1. Tractor Maintenance: Principles and Procedures, Unit III, Part Three; Unit I-III, Part Four.

2. Tractors and Crawlers, Chapter 5.

3. Tractor Maintenance and Tune-Up, pages 14-19.

4. Electrical, International Harvester, pages 25-30 and 35-41.

5. Ford Tractor: Shop Manual, Chapters II and III.

6. Gulf Farm Tractor Guide, pages 27-30.

7. Farm Tractor Tune-Up and Service Guide.

8. Modern Farm Power, pages 102-130.

9. Farm Tractors: Basic Principles, Operation, and Maintenance, pages 46-55.

Suggested Occupational Experiences

Each student should service at least one complete electrical system following procedures listed in the content. Students should make note of problems encountered and present these to the class.

V . To maintain and adjust tractor air, fuel, and exhaust system

Teacher Preparation

Subject Matter Content

Studies have shown that properly maintained air cleaners may lower fuel consumption by as much as 22.5 per cent. Horsepower

has been increased by as much as 27 per cent as a result of a properly cleaned and adjusted air cleaner.

Two common types of air cleaners used on tractors are:

1. Dry type
2. Oil bath type

To clean and service the oil bath air cleaner the following procedure should be used:

1. Remove oil cup and screen tray.
2. Inspect center tube and lower filter element.
3. Remove dirt from center pipe.
4. Clean dirt from lower filter (Do not try to remove a permanently installed filter element,)
5. Clean shell and upper metal-wool filter.
6. Drain filter body and screen for several minutes. (Diesel engine air cleaner filter screens must be completely dry before reinstalling if washed in a volatile solvent to prevent the possibility of the engine "running away.")
7. Clean the screened air intake, cap, or precleaner.
8. Reassemble filter parts.

Dry type air cleaners are now being used on many new tractors. The efficiency of this type cleaner is outstanding. Also the expense and mess of cleaning and replacing the oil in the oil-bath type are eliminated.

Dry type air cleaners should be serviced by the following procedure:

1. Stop engine if it is running.
2. Squeeze dust unloader if one is on the air cleaner.
3. Remove hood or grill if necessary to provide access to air cleaner unit.

4. Wipe off dust accumulated around end of cleaner where element will be removed.

5. Loosen hand screw or clamp that holds the end cap on the end of the cleaner and remove cap.

6. Clean the area around the element and clean the dust cup and baffle on air cleaners having end cups.

7. Remove filter element from cleaner.

8. Check condition of rubber gasket on end of filter element.

9. Clean filter element by:

   a. Tapping to loosen dust so it can be shaken out, or

   b. Use compressed air and blow from inside to outside, or

   c. Rinse in warm water and a low sudsing detergent.

10. Allow element to dry if washed.

11. Inspect element for damage.

12. Replace element in the cleaner and complete job by following procedure in reverse order from that used in removing the filter element.

The purpose of tractor fuel systems is to supply fuel to the engine.

Properly adjusted fuel systems result in an increase in horsepower and may result in a reduction in fuel consumption.

Servicing and tuning the fuel system for gasoline engines include several activities, following the manufacturer's recommendations, namely:

1. Servicing the sediment bowl, fuel filter, and fuel line:

   a. Close valve(s) on fuel supply line.

   b. Loosen nut that holds sediment bowl in position.

   c. Remove sediment bowl.

d. Remove sediment bowl gasket.

e. Remove strainer.

f. Wash strainer unless it is a disposable type.

g. Clean sediment bowl.

h. Open fuel valve and allow fuel to flow through to clean line between sediment bowl and tank.

i. Reinstall gasket, strainer, and sediment bowl.

j. Tighten nut that holds sediment bowl in position.

k. Open fuel valves and check for leaks.

2. Preparing for carburetor adjustment:

a. Determine if carburetor is equipped with a screen.

b. Close valve on fuel line and disconnect line at carburetor.

c. Remove screen from carburetor (if applicable).

d. Clean the screen and reassemble.

e. Start engine and check for air leaks around manifold connections and carburetor gaskets.

3. Adjusting idling speed screw:

a. Start engine and warm to operating temperature.

b. Set speed control lever at closed position.

c. Locate idling speed adjustment.

d. Adjust screw to normal idling speed.

4. Adjusting the idling fuel-air mixture:

a. Set speed control lever at idling position.

b. Locate idle-mixture adjusting screw.

c. Turn idle-mixture screw clockwise slowly until engine begins to "roll" or slow down.

d. Turn adjusting screw back slowly until engine runs smoothly.

5. Adjusting the load fuel-air mixture:

a. Run engine at full throttle either with or without load.

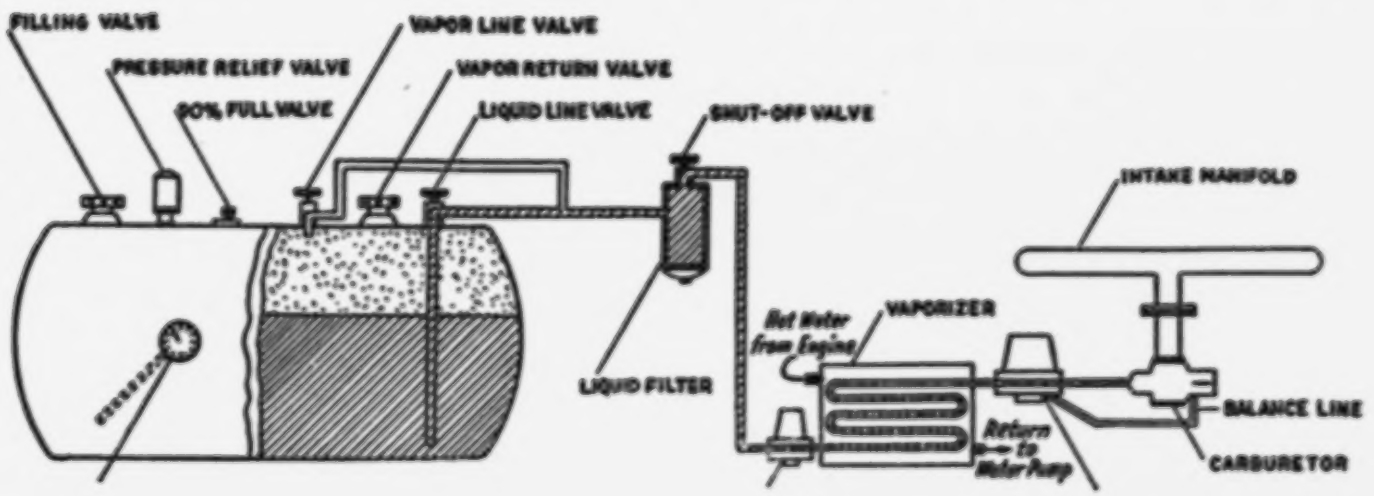
b. Turn load adjusting screw clockwise until engine begins to lose power.

c. Turn adjusting screw counter clockwise until engine gives off black smoke from exhaust.

d. Turn screw clockwise until engine runs smoothly and at full speed.

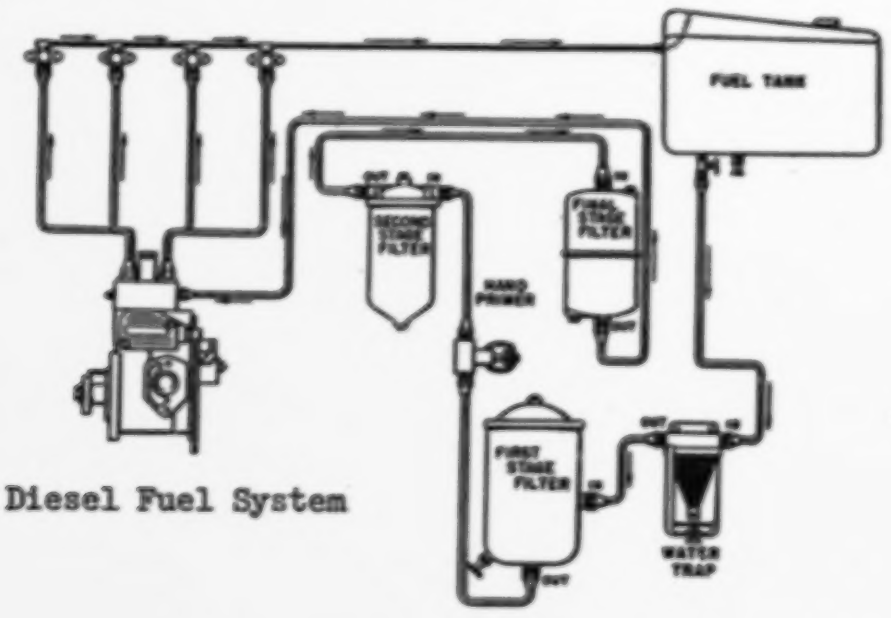
e. Check carburetor adjustment by accelerating engine quickly while under load.

Too lean a mixture will cause the engine to back fire and too rich a mixture will produce dark colored smoke.



LP Gas Fuel System

Fuel systems for LP Gas engines are basically the same as for gasoline engines with three or four exceptions. Main differences in a gasoline system and an LP Gas system are that the gas system has a different fuel filter, a vaporizer, and a regulator. The LP Gas carburetor does not have a float because the fuel enters the carburetor as a gas rather than as a liquid.



Diesel Fuel System

Servicing and adjusting LP Gas fuel systems should be according to procedures suggested by the manufacturer.

Fuel systems for some makes of diesel tractors are very complicated. For that reason it is advisable that servicing, other than servicing the fuel filters and bleeding the fuel lines, be left to mechanics highly skilled in this area.

Clean fuel, free from moisture and foreign matter, is essential for proper functioning of a diesel fuel system; therefore, filters must be carefully serviced regularly.

To replace fuel filters or to clean permanent type filters follow this procedure:

1. Turn off fuel supply at tank.
2. Clean outside of filter body and engine area around filter. Wipe dry.
3. Drain fuel from filter.
4. Remove old filter.
5. Wash filter as described under fuel systems for gasoline engines.

6. Clean inside of filter bowl (unless it is a self-contained type).

7. Reinstall cleaned filter or new disposal filter element.

8. Complete the filter assembly and tighten it.

9. Replace the drain plug or tighten the drain valve.

Servicing filters usually results in considerable air being left in the filter body and fuel line. Air in the filter and fuel line may cause an air lock when starting the engine. To prevent this condition, the fuel lines should be bled to remove the air.

The procedure that follows is about the same for bleeding first, second, and third stage filters.

1. Open the fuel tank, shut-off valve at the bottom of the tank.

2. Open the drain cock at the bottom of the fuel filter base. Close the drain cock when the fuel begins to flow.

3. Open the bleed screw at the top of the filter cover to release air that may be trapped. After a solid flow of fuel appears, tighten the bleed screw.

Servicing the manifold, muffler, and exhaust pipe usually is limited to checking for leaks and restrictions and cleaning drain holes on horizontal mufflers. Poor engine performance and burned valves will result from restrictions in the exhaust system.

Servicing the manifold includes removing the manifolds from the engine for thorough cleaning. Deposits of gum may be found inside the intake manifold as well as carbon deposits inside the exhaust manifold. They should be soaked in a good solvent to loosen gum and carbon deposits then dried thoroughly before being reinstalled.

The purpose of a governor on an engine is to automatically regulate the throttle so as to maintain a uniform rate of engine speed regardless of the load.

An improperly adjusted governor causes a loss of horsepower and may cause an increase in fuel consumption.

Governed engine speed, linkage, and other adjustments vary according to engine manufacturer; therefore, it is best to follow the recommendations of the manufacturer found in the service or operator's manual.

Suggested Teaching-Learning Activities

1. After demonstrating proper service techniques, have a student in the class redemonstrate proper technique to the entire class.

2. Have students trouble shoot and service an air, fuel, or exhaust system that has been deliberately "fouled up" by the teacher.

3. Have students report on principles and functions of air, fuel, and exhaust systems.

4. Have students identify major components of air, fuel, and exhaust systems.

5. Have students give reasons for steps suggested in procedures in content.

Suggested Instructional Materials and References

Instructional Materials

1. Charts and diagrams of air, fuel, and exhaust systems

2. Overhead transparencies, preferably overlays, of air, fuel, and exhaust systems. The overlays should be in colors to better illustrate the principles involved and the functions of the parts.

3. One of each type air cleaner

4. Tractors for demonstrations and laboratory experiences for students

5. A set of necessary tools for each student

6. "Fuel System & Fuel Storage," University of Nebraska Filmstrip.

References

1. Tractor Maintenance: Principles and Procedures, pages 53-66, 93-98, 115-117, 126-127.

2. Tractors and Crawlers, pages 144-146.

3. Farm Tractors: Basic Principles, Operation, and Maintenance, pages 31-34.

4. Ford Tractor: Shop Manual, pages 85-149.

Suggested Occupational Experiences

1. Have students completely service and adjust the air, fuel, and exhaust systems on at least two gasoline and two diesel tractors.

2. Have students report to the class on problems encountered.

VI. To maintain and adjust the tractor cooling system

Teacher Preparation

Subject Matter Content

The purpose of the cooling system is to help dispel the excess heat energy from the engine. Only about one-third of the potential heat energy in the tractor engine is turned into useful power and heat. The rest of the heat must be dispelled or the engine will be destroyed. This is accomplished through the exhaust system.

Overheating an engine is likely to caust sticking and burned valves, a cracked engine or block, or excessive engine knock.

There are two types of water cooling systems used on tractors, namely:

1. Thermo-siphon

2. Forced circulation

Three conditions which develop in cooling systems but which can be controlled through proper maintenance are:

1. Mineral deposits

2. Rust

3. Galvanic corrosion

FREEZING PROTECTION TABLE

Cooling System Capacity in Quarts	"PERMANENT" ANTIFREEZE REQUIRED (Quarts)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	(Degrees F.)												
5	16°	-12°	-62°										
6	19°	0°	-34°										
7	22°	7°	-17°	-54°									
8	23°	11°	- 7°	-34°	-69°								
9	24°	14°	0°	-21°	-50°								
10	25°	16°	4°	-12°	-34°	-62°							
11	26°	18°	8°	- 6°	-23°	-47°							
12		19°	10°	0°	-15°	-34°	-57°						
13		21°	13°	3°	- 9°	-25°	-45°	-66°					
14			15°	6°	- 5°	-18°	-34°	-54°					
15			16°	8°	0°	-12°	-26°	-43°	-62°				
16			17°	10°	2°	- 8°	-19°	-34°	-52°				
17			18°	12°	5°	- 4°	-14°	-27°	-42°	-58°			
18			19°	14°	7°	0°	-10°	-21°	-34°	-50°	-65°		
19			20°	15°	9°	2°	- 7°	-16°	-28°	-42°	-56°		
20				16°	10°	4°	- 3°	-12°	-22°	-34°	-48°	-62°	
21				17°	12°	6°	0°	- 9°	-17°	-28°	-41°	-54°	-68°
22				18°	13°	8°	2°	- 6°	-14°	-23°	-34°	-47°	-59°
23				19°	14°	9°	4°	- 3°	-10°	-19°	-29°	-40°	-52°
24					15°	10°	5°	0°	- 8°	-15°	-24°	-34°	-46°

Adjust and maintain the cooling system through the following procedure:

1. Check radiator air passages to make sure they are free of foreign materials.

2. Check hose and hose clamps.

3. Check fan belt to make sure it is not broken or slipping. If the belt is slipping, it may be tightened by shifting the position of the generator, if it is driven by the fan belt, or by changing the position of an adjustable sheave on the fan pulley.

4. Check for external leaks other than those caused by loose hose clamps.

5. Flush cooling system if rust shows in the coolant. If a commercial flushing compound is to be used follow the instructions on the container.

6. Refill with coolant. Use clean soft water and add rust inhibitor or new antifreeze.

7. Change the antifreeze each year. Engine gases escape through the walls of the engine into the coolant changing the antifreeze into an acid.

Suggested Teaching-Learning Activities

1. Have students learn the components of cooling systems.

2. Have students list advantages and disadvantages of the two types of water cooling systems.

3. Have students report on causes of fouled cooling systems.

4. Demonstrate the difference in "boiling off" rates between alcohol and ethylene-glycol antifreeze with the resultant difference in protection levels.

5. Have students list several kinds of antifreezes and give good and bad points about each.

6. Attach a hose to the bottom of a five-gallon pail. Fill the pail half full with antifreeze and test for acidity with litmus paper. Attach the other end of the hose to the exhaust of a tractor engine. Start the engine forcing the exhaust fumes through the antifreeze.

Allow the engine to run about eight minutes. Then shut off the engine and let the antifreeze cool. After the antifreeze has colled to normal temperature, test it again with the litmus paper.

7. Demonstrate by placing clean iron in an old antifreeze solution that rust-inhibitive qualities are lost after prolonged usage.

8. Demonstrate how to check old thermostats for reliability.

9. Prepare a chart showing the amount of excessive cylinder wear, fuel consumption, and power loss caused by too low an engine operating temperature using the following data:

For a 60-hour gasoline engine test -

Operating temperature				
40° F	100° F	140° F	160° F	180° F
Fuel consumption				
3.8 gph	3.5 gph	3.2 gph	2.9 gph	2.8 gph
Cylinder wear				
.008"	.002"	.001"	.0005"	.0003"
Power				
26 hp	27.2 hp	28.5 hp	29 hp	29.5 hp

Suggested Instructional Materials and References

Instructional Materials

1. Charts on cooling system
2. Samples of flushing compounds and antifreezes
3. Tractors for demonstrations and experiences
4. Charts - The Engine Cooling System
5. "Cooling System," University of Nebraska Filmstrip.

References

1. Tractor Maintenance: Principles and Procedures, pages 105-111.

2. Farm Tractors: Basic Principles, Operation and Maintenance, pages 58-65.

3. Tractors and Crawlers, pages 172-174.

4. Farm Tractor Tune-up and Service Guide.

Suggested Occupational Experiences

1. Have students completely service at least one cooling system.

2. Have students report unusual findings to the class.

VII. To maintain and adjust the power train

Teacher Preparation

Subject Matter Content

The power train of a tractor is considered to be the parts to the rear of the tractor engine that transmit engine power to the rear wheels or power take-off shafts.

Power trains vary in design according to manufacturers; therefore, it is advisable to follow procedures suggested by manufacturers when adjusting the power train. However, all manufacturers include basic components that are similar in design.

The clutch is a device for disconnecting the tractor engine from its lead while starting and idling. Clutches are either hand or foot operated. Regardless of the type used, the principle of operation is the same.

To adjust foot-operated clutches follow this procedure:

1. Determine from the operator's manual how much free travel is needed. This varies from $\frac{1}{2}$ inch to $1\frac{1}{2}$ inches.

2. Check clutch pedal for free travel.

3. Locate means provided for clutch adjustment.

4. Adjust linkage until clutch pedal has sufficient free travel.

5. Tighten locknut so that it holds adjustment securely.

To adjust hand-operated clutches follow these steps:

1. Check clutch-lever action to determine if adjustment is needed.
2. Disengage the clutch.
3. Place gear shift lever in neutral.
4. Remove hand hole cover on housing.
5. Turn clutch by hand until locking mechanism is on side next to hand hole.
6. Loosen lock and tighten collar one notch at a time or as recommended by operator's manual.
7. Check clutch lever for proper operation.
8. Replace lock pin and make certain it is properly seated.
9. Replace hand hole cover.

Servicing the remainder of the power train is limited primarily to the drive mechanism. Tests have shown that changing oil properly and at proper intervals in the transmission, final drive, and other parts of the drive train increases the life and efficiency of the tractor and reduces maintenance cost by as much as 5 per cent. Servicing the drive trains should be done in the following manner:

1. Drive the tractor until gear oil is thoroughly heated.
2. Place the tractor on a level surface.
3. Remove the drain plug(s) and clean, if of the magnetic type.
4. Replace the transmission oil filter, if the tractor has a filter.
5. Replace the drain plug(s).
6. Refill with the amount, type, and grade of lubricant recommended by the operator's manual.
7. Flush and drain gear case(s) with flushing oil on diesel fuel.

8. Clean filler plug and surrounding area.

9. Refill with proper type and grade of gear lubricant.

10. Replace filler plug(s).

11. Clean breather(s).

Suggested Teaching-Learning Activities

1. Have students list faulty mechanical or operational conditions which may develop due to an improperly serviced power train.

2. Have students diagram and label components of a power train.

3. Have students determine kinds of lubricants to be used in servicing the power train.

4. Have students list reasons for properly adjusting clutches.

5. Show students worn out clutch assemblies caused by improper adjustment or lack of attention.

6. Demonstrate proper clutch adjustment technique on cutaway clutch assemblies to more clearly present the necessity for proper clutch adjustment.

7. Demonstrate with a cutaway differential housing and one differential gear operated by an electric motor why the proper grade and type of lubricant is needed to furnish proper protection.

Suggested Instructional Materials and References

Instructional Materials

1. Charts and diagrams of power trains of different makes of tractors

2. Tools needed for this activity

3. Tractors

4. Cutaway models of power trains

References

1. Tractor Maintenance: Principles and Procedures, pages 71-75, 117-121.
2. Tractors and Crawlers, pages 178-245.
3. Farm Tractor Tune-Up and Service Guide.

Suggested Occupational Experiences

1. Have students adjust hand operated and foot operated clutches.
2. Have students service the power train components of a tractor.

VIII. To adjust tractor brakes

Teacher Preparation

Subject Matter Content

Brakes on tractors are used for stopping and for assistance in making short turns.

Three types of brakes used on tractors are:

1. External band brakes (external contracting)
2. Shoe brakes (internal expanding)
3. Disc brakes (mechanical, hydraulic and power)

To adjust mechanical brakes follow this procedure:

1. Check to see what provision is made for brake adjustment.
2. Jack up rear of tractor until both rear wheels clear the ground.
3. Release brake lock(s).
4. Complete the preliminary arrangements for adjustment of first brake.

5. Tighten adjusting screw, adjusting rod, or adjusting nut.

6. Complete reassembly, or tightening of lockmuts, to maintain adjustments.

7. Adjust second brake in the same manner as the first one.

8. Check to make certain that the brakes are equalized.

9. Lower tractor from jack(s).

Hydraulic brakes do not require the same adjustments as mechanical brakes. Procedures listed in the operator's manual should be followed if air bleeding is necessary.

Suggested Teaching-Learning Activities

1. Show students examples of brake failures caused by different conditions.

2. Demonstrate the necessity for equalizing brake adjustments by driving a tractor with unequalized brakes on dry pavement. Show the difference in brake drum temperatures at the end of the demonstration.

3. Develop a clipping file of farm accidents caused by brake failures and present to the class.

4. Have students list types of brakes and give advantages of each.

5. Have students list reasons for keeping brakes properly adjusted.

Suggested Instructional Materials and References

Instructional Materials

1. Charts and diagrams of brake systems

2. Tractors for demonstration and practice

3. A set of tools for each student necessary for the activity

4. Overhead transparencies of brake systems

References

1. Tractor Maintenance: Principles and Procedures, pages 66-71.
2. Tractors and Crawlers, pages 248 - 261.
3. Farm Tractor Tune-Up and Service Guide

Suggested Occupational Experiences

Have students adjust at least two types of brakes.

IX. To maintain and adjust steering mechanisms and wheels

Teacher Preparation

Subject Matter Content

Steering mechanisms vary in design. Maintenance and adjustments on steering mechanisms should be according to the recommendations of the manufacturers. Maintenance and adjustments usually consist of lubricating properly and tightening connections.

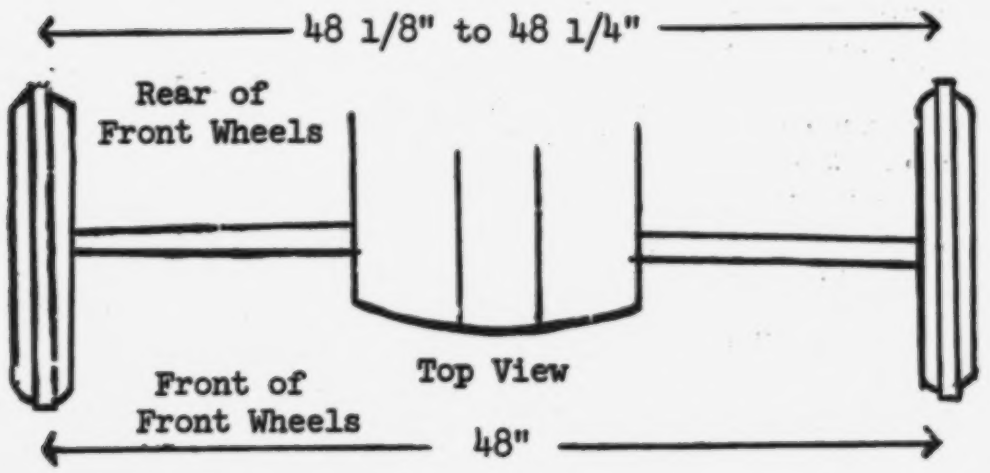
Operator's manuals for the make of tractors used in the laboratory should be secured and followed in developing this competency.

Servicing tractor wheels includes several activities. These activities are:

1. Checking wheel alignment (for standard type tractors)
2. Checking tires
3. Servicing front wheel bearings

Proper front wheel alignment reduces tire wear and makes steering easier. Proper toe-in is 1/8 inch to 1/4 inch. This means the total distance between the centerlines at the front of the tires should be 1/8 to 1/4 inch less than the total distance between the centerlines at the rear of the tires.

Example of Checking Toe-In



Toe-in adjustment is made by adjusting the clevis on the end of the tie rod.

Properly inflated tires last longer and help the tractor deliver satisfactory drawbar pull.

Tire inflation should be checked by the following procedure:

1. Remove valve cap and check pressure with guage. If pressure is checked with valve stem in the top position, add 1/2 pound per foot of liquid height.

2. Add air (or deflate) as needed to secure proper pressure.

3. Wash guage with clean water after using on tires containing calcium-chloride solution.

4. Replace valve cap.

Tires should also be checked for cuts, breaks, nails, stones, etc.

Much damage may result if grit and dirt particles are allowed to enter the bearings. Proper servicing helps prevent this condition.

Some tractors are equipped with grease fittings for gun lubrication. This type should be greased daily so the new grease

will work out around the dust seal and remove grit and dirt particles. These bearings should be thoroughly cleaned and repacked at least once a year.

Bearings on tractors without grease fittings must be serviced more frequently. To service this type bearing, follow this procedure:

1. Raise front wheels off the ground.
2. Clean dirt from wheel and hub cap and remove hup cap.
3. Remove cotter pin and adjusting nut.
4. Remove thrust washer and outer bearings.
5. Pull wheel off the spindle.
6. If the inner bearing remained in the hub, remove it.
7. Wash bearings thoroughly in a good grade solvent.
8. Remove all solvent from bearings and other washed parts, or else use gasoline and let parts air dry.
9. Examine bearings for wear.
10. Examine grease-retainer ring and seal. Replace if damaged.
11. Clean hub, hub cap, and spindle.
12. Pack each bearing with grease.
13. Replace inner bearing and grease-retainer seal if removed originally.
14. Coat spindle and inside of hub with grease.
15. Position wheel on spindle and install outer bearing.
16. Install thrust washer and slotted adjusting nut.
17. Turn wheel and tighten castellated nut until wheel just begins to drag, then back off the amount recommended by the operator's or service manual; or, tighten castellated nut to proper torque with torque wrench.

18. Lock nut with cotter pin.

19. Replace hub cap.

Suggested Teaching-Learning Activities

1. Have students develop a table of operating pressures for farm tractor tires.

2. Have students report on different types of tractor tires which should be installed for different soil or use.

3. Prepare a collection of sections of tire carcasses showing the following conditions:

   a. Weather checking caused by over-inflation or long exposure to sunlight

   b. Sidewall buckling and cord injury caused by under-inflation

   c. Diagonal or "x"-type breaks caused by over-inflation

   d. Tread-wiping caused by excessive operation on pavement

4. Develop a collection of wheel bearing assemblies ruined by:

   a. Lack of grease

   b. Excessive tightening of the castellated nut

   c. Dirt and grit accumulated because of worn out grease seals or because of lack of attention to cleanliness when packing the bearings

   d. Not removing solvent from bearings and races before repacking thereby preventing the grease from adhering to the metal surfaces

5. Make a toe-in calibration adjustment bar out of 1/2" pipe or hardwood and a chalk holder to demonstrate toe-in measurements.

6. Have students report on different types of front wheel assemblies and type of bearings used on tractors.

Suggested Instructional Materials and References

Instructional Materials

1. Charts and diagrams of steering mechanisms and wheel and bearing assemblies
2. Tractors
3. Tools for student use necessary for this competency

References

1. Tractors and Crawlers, pages 102-118.
2. Tractor Maintenance: Principles and Procedures, pages 28-32, 99-104.

Suggested Occupational Experiences

1. Have students align front wheels on a tractor.
2. Have students check and service tires on a tractor.
3. Have students clean and service front wheel bearings on at least one tractor.

X. To select and use proper lubricants for tractors

Teacher Preparation

Subject Matter Content

If the person being taught this module on "Tractor Tune-up and Maintenance" has not been taught the competency on understanding agricultural machinery lubrication included in the module on "Agricultural Machinery Assembly and Lubrication," he should be taught that competency at this time.

Suggestions for Evaluating Educational Outcomes of the Module

The educational outcomes of this module should be evaluated according to attitudinal changes and manipulative skills developed.

1. Manipulative skills

It is suggested that each student be required to perform a complete engine service tune-up, check and adjustment of those systems usually included in a tune-up and service operation. The teacher should observe the performance of each student to evaluate the student's accomplishments. Also, it is suggested that the student use a dynamometer in performing the tune-up operation. The use of the dynamometer should be demonstrated thoroughly to the student prior to this activity.

A suggested sequence for the servicing and tune-up of a gasoline tractor:

a. Remove spark plugs, inspect, then clean and regap or replace them as necessary.

b. Test engine compression.

c. Adjust valve clearance.

d. Remove distributor, disassemble, clean, recondition, and relubricate.

e. Regap breaker points or replace if necessary.

f. Inspect distributor rotor, cap, and ignition cables.

g. Clean fuel sediment bowl and screen.

h. Remove and clean crankcase oil pan and the oil pump screen.

i. Check carburetor fuel level.

j. Adjust carburetor fuel level, recondition or replace float valve assembly as necessary, and replace the bowl gasket.

k. Inspect the air cleaner and connections.

l. Remove and wash air filter screens and cup and replace hose if necessary

m. Install the spark plugs with new gaskets.

n. Check and correct ignition timing.

o. Cover the radiator and run the engine until it reaches normal operating temperature.

p. Adjust carburetor idle mixture and idle speed of the engine.

q. Check main fuel adjustment screw setting of the carburetor.

r. Adjust fast idle governed speed.

s. Check cooling system for pressure build-up at the radiator cap, coolant flow, and inspect the condition of the cap, upper and lower hoses, and the radiator core.

t. Flush the cooling system, clean the radiator fins, and replace hoses as necessary.

u. Inspect and adjust both fan and generator belts as necessary.

v. Inspect and adjust brakes.

w. Inspect and adjust clutches.

x. Inspect and service tires.

y. Check toe-in of front wheels.

z. Inspect and make necessary corrections in lights.

2. Attitudes

Attitudes should be evaluated according to:

a. Student participation in class discussions

b. Student response to assignments made

c. Carefulness and thoroughness of jobs performed

Sources of Suggested Instructional Materials and References

Instructional Materials

1. "Cooling System," Lincoln, Nebraska, University of Nebraska, College of Agriculture, Department of Agricultural Education.

2. "Electrical System," Lincoln, Nebraska, University of Nebraska, College of Agriculture, Department of Agricultural Education.

3. "Fuel System and Fuel Storage," Lincoln, Nebraska, University of Nebraska, College of Agriculture, Department of Agricultural Education.

References

1. Bedell, Earl and Frazee, Irving. Tractors and Crawlers, Chicago, Illinois: American Technical Society, 1963.

2. Henderson, G. E. and Turner, J. Howard. Farm Tractor Tune-Up and Service Guide, 1963, Southern Association Agricultural Engineers and Vocational Agriculture, Barrow Hall, Athens, Georgia. Price: $1.85.

3. Henderson, G. E. and Turner, J. Howard. Tractor Fuels and Lubricants, 1964. Southern Association Agricultural Engineers and Vocational Agriculture, Barrow Hall, Athens, Georgia. Price: $1.20.

4. Henderson, G. E. and Turner, J. Howard. Tractor Maintenance: Principles and Procedures, 1964. Southern Association Agricultural Engineers and Vocational Agriculture, Barrow Hall, Athens, Georgia. Price: $3.25.

5. Promersberger, W. J. and Bishop, F. E. Modern Farm Power, Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1962.

6. Electrical, 1961. International Harvestor Company, 180 N. Michigan Avenue, Chicago, Illinois, Price: $1.50.

7. Farm Tractors: Basic Principles, Operation, and Maintenance, Engineering Bulletin No. FT-53, American Oil Company, New York City, New York. No Charge.

8. Gulf Farm Tractor Guide, Gulf Oil Corporation, Gulf Building, Houston, Texas. No. SP10293, No charge.

9. Implement and Tractor Shop Manual. Implement and Tractor Publications, Inc., 1014 Wyandotte Street, Kansas City, Missouri.

10. Implement and Tractor Tune-up Specifications. Implement and Tractor Publications, Inc., 1014 Wyandotte Street, Kansas City, Missouri.

11. "Nebraska State Test and Chart for P.T.O. Speed, Fuel Compression and Horsepower," Agricultural Engineering Department, College of Agriculture, Lincoln, Nebraska.

12. Tractor Maintenance and Tune-Up, 1962. International Harvestor Company, 180 North Michigan Avenue, Chicago 1, Illinois. Price: $1.50.

13. Ford Tractor: Shop Manual, 1955-60. Tractor and Implement Division, Ford Motor Company, Dearborn, Michigan.

THE CENTER FOR RESEARCH AND LEADERSHIP DEVELOPMENT
IN VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY
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COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
   _____Ornamental Horticulture--Service Occupations
   _____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
   _____

6. How many students:
   a) Were enrolled in class (total) _____
   b) Participated in studying this module _____
   c) Participated in a related occupational work experience program while you taught this module _____

7. Actual time spent teaching module:

		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

_____ _____
(Date) (Instructor's Signature)

_____
(School Address)